Structure dynamics of epitaxial VO_2 film on c-Al_2O_3 by using an in-air time-resolved X-ray diffraction

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The lattice motion and displacement of atoms were characterized for the unit cell in vanadium dioxide (VO_2) grown on Al_2O_3 using static and time-resolved X-ray diffraction (XRD). The monoclinic–tetragonal phase transition of the VO_2 unit cell and the twist motion of vanadium atoms in the unit cell were observed. The time-resolved XRD measurements were performed in air with a table-top high-repetition femtosecond laser. Typical X-ray diffraction spectra are shown in Fig. 1. The results from the time-resolved XRD measurements suggested that the unit cell of low-temperature monoclinic VO_2 transformed into the high-temperature tetragonal phase very fast; however, the atoms in the unit cell fluctuated with the center of the tetragonal coordinate within about 100 ps. The propagating time scale of 100 ps corresponded well to the previously reported time scale of shear motion measured with femtosecond optical measurements or crystallography [1,2]. Thus, the time-resolved XRD measurements of the Bragg angle, intensity and width of the diffraction lines revealed the phase transition of VO_2 and the atomic motion in the unit cell simultaneously.

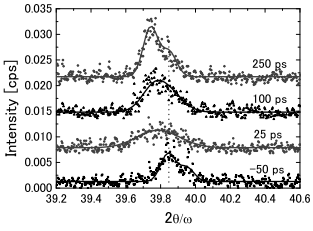

Figure 1: The typical spectra of the time-resolved XRD line from the (020) plane of VO_2. (at -50, 25, 100 and 250 ps, as marked)

[1] A. Cavalleri, Cs. Toth, C.W. Siders, J.A. Squier, F. Raksi, P. Forget, J.C. Kieffer, Phys. Rev. Lett. **87**, 237401 (2001).

[2] P. Baum, D.-S. Yang, A.H. Zewail, Science **318**, 788 (2007).